02-ASD-367 (SR)

TITLE OF INVENTION **DISSIPATING HEAT IN AN ARRAY OF CIRCUIT COMPONENTS**

INVENTORS: **JOSEPH J. SPRYSHAK**

Express Mail" Mailing Label No. **EU 505 570 731 US**. Date of Deposit **June 25, 2003** I hereby certify that this paper or fee is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" Service under 37 CFR 1.10 on the date indicated above and addressed to the Mail Stop Application, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450

Name of Sender: **Lorelei K. Dingethal**

Lorelei K Dingethal

Signature of Sender

TITLE OF INVENTION

[0001] Dissipating Heat In An Array Of Circuit Components.

BACKGROUND OF THE INVENTION

[0002] The present invention relates to electrical components of the type mounted on a circuit board such as, for example, resistors, capacitors, photo detectors and photo emitters such as light emitting diodes (LEDs). These latter devices may be mounted individually or in closely spaced arrangement in an array where relatively high illumination is required in a relatively small area. In such arrays, it has been found difficult to remove the heat at a sufficient rate to prevent the LEDs from overheating and resultant premature failure.

[0003] Presently LEDs are limited in further increases in illumination power by the inability to keep the junction temperature within a range that the efficiency and life expectancy of the device is acceptable.

[0004] Currently, it has been found desirable to employ LEDs in automotive illumination applications. LEDs are desirable in such applications because of their higher efficiency in terms of light intensity output as a function of the electrical energy input as compared with incandescent bulbs. However, LEDs have the disadvantage that they have a much lower operating temperature limit than incandescent bulbs. In such automotive applications the environment in which the LEDs must operate subjects them to ambient temperatures higher than typically encountered in indoor stationary applications.

[0005] In applications where the LEDs are arranged in closely spaced arrays, it has been desired to find a way or means of economically removing the heat from the diode array in order to prevent exceeding the operating temperature of the individual LEDs. This latter problem is particularly troublesome where the LEDs are mounted directly on a circuit board for economies of space and ease of manufacture. This has been desired to find a way or means of providing increased cooling for an array of closely spaced circuit components, particularly

LEDs mounted directly on a circuit board.

BRIEF SUMMARY OF THE INVENTION

[0006] It is an object of the present invention to provide an improved technique for removing heat from an array of electrical circuit components such as LEDs mounted directly on a circuit board.

[0007] The present invention provides a solution to the above-described problem of removing heat from circuit components mounted on a circuit board and particularly solves the problem of removing heat from a closely spaced array of circuit components mounted directly on a circuit board and more particularly LEDs in a manner which is easy to manufacture and relatively low in cost for high volume production.

[0008] The technique of the present invention employs conductive strips arranged in a pattern on the front and back face of the circuit board with the LEDs mounted in an array on one side of the board and connected to the conductive strips on the front and back sides of the board. Additional thermally conductive vias pass through the board to conduct heat between the front and back layers of conductive strips. The circuit components are connected to the strips and thermally conductive tape is applied over the pattern of conductive strip on the front and back of the board; and, heat sinks are disposed in direct contact with the surface of the tape for conducting heat from the conductive strips through the thermally conductive tape on the front and back faces of the board and outwardly through the heat sinks. Thus, heat is conducted through the conductive strips and the thermally conductive tape to the heat sink on both the front and back sides of the board from an array of circuit components, particularly LEDs mounted on only one side of the board.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. 1 is a perspective view of the circuit board assembly of the present invention;

[0010] FIG. 2 is a section view taken along section indicating lines 2-2 of FIG. 1; and,

[0011] FIG. 3 is an enlarged perspective view of a portion of FIG. 2.

DETAILED DESCRIPTION OF THE INVENTION

[0012] The present invention may be embodied in an assembly indicated generally at 10 in FIG. 1 and includes a circuit board 12 having a plurality of circuit components such as LEDs 14 mounted thereon in relatively closely spaced array and preferably staggered arrangement on the front face of the board. Although the circuit components are shown in the illustrated embodiment as mounted in an array on one face of the board, it will be understood that alternatively the circuit components may be mounted on both the front and back faces. The front and back faces of the board each have disposed thereon a plurality of conductive strips arranged in a pattern with the strips denoted by reference numerals 16, 18 in FIG. 2. The strips may be interconnected by a plurality of thermally conductive vias 20 preferably in the form of hollow rivets to conduct heat from the strips on one side of the board through the board to the strips on opposite side or face of the board. Optionally, the vias 20 may be additionally filled with thermally conductive material such as copper to improve the thermal conductivity thereof.

[0013] Referring to FIGS. 2 and 3, each of the LEDs 14 has a pair of electrical leads 22, 24 respectively which are attached to individual separate strips of the pattern of strips 18 on the front face of the board by electrically conductive leads 22, 24. In the present practice of the invention the leads 22, 24 are attached to the strips 18 by soldering, but other suitable expedients, as for example, resistance or laser weldment may be employed.

[0014] As shown in FIG. 1, the LEDs are preferably arranged in a staggered array with the board disposed in the vertical position shown in FIG. 1 in order to minimize an accumulation of the heat from lower adjacent diodes by upwardly convective air currents passing through the diode array.

[0015] Referring to FIGS. 2 and 3, a layer of thermally conductive tape 26 is disposed over the front face of the board and has a plurality of cut-outs or voids 28 formed therein to accommodate the diodes; and, similarly a layer of thermally conductive tape 30 is disposed in direct contact with the back face of the board. In the present practice of the invention, it has been found satisfactory to employ thermally conductive electrically non-conductive double-sided adhesive tape for both layers 26, 30; and, the tape has a thermal conductivity of about 0.4 Watts per meter – K as measured per ASTMD5470. In the presently preferred practice of the invention the tape is formed of polymeric film material coated with thermally conductive acrylic adhesive on opposite sides of the tape; and, the tape has a thickness of about 0.18 mm. One commercially available tape which has been found satisfactory is available from the Bergquist Company, 1893 West 18th Street, Chanhassen, Minnesota 55317, bearing manufacturer's identification 660; however, any suitable thermally conductive tape may be employed.

[0016] Referring to FIGS. 1 through 3, the front face of the board has a heat sink 32 disposed directly against the thermally conductive tape 26; and, the heat sink 32 has a plurality of voids or cut-outs 34 formed therein to provide clearance for the diode array. Optionally, the heat sink 32 may be finned for improved convective cooling. Preferably, the cutouts and the pattern of the LEDs are such that the LEDs are equidistant from the edge of the heat sink to minimize "hot-spots".

[0017] A heat sink 36 is disposed in direct contact with the layer of tape 30 on the back face of the circuit board; and, the heat sink 36 may also be vertically finned as shown in FIG. 1. Thus, the thermally conductive tape layers 26, 30 are effective to conduct heat from the conductive strips 16, 18 outwardly from the board and thereby provide a direct path for conducting heat away from the diodes through the board.

[0018] It will be understood that the construction of the assembly 10 of the present invention provides improved heat transfer from an array of circuitry components on a circuit board in orientations other than the vertical as, for

example, when the board is inclined at an angle of about 40 to 45 degrees to the vertical as may be encountered in certain automotive applications. The present invention thus provides a unique and novel assembly of a circuit board with an array of circuitry components thereon and particularly LEDs, which generate substantial amounts of heat during electrical energization and provides for transfer of the heat through the conductive strips of the board to which the LEDs are electrically attached through vias to the strips on the opposite face and effects transfer of the heat through thermally conductive double-sided tape contacting the strips on both faces of the board and to heat sinks disposed against opposite side of the tape on both sides of the board. .

[0019] Although the invention has hereinabove been described with respect to the illustrated embodiments, it will be understood that the invention is capable of modification and variation and is limited only by the following claims.